

Forest Pest Management *Pacific Northwest Region*



FOREST PEST SURVEY
MCKENZIE RIVER CORRIDOR
MCKENZIE RANGER DISTRICT
WILLAMETTE NATIONAL FOREST



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WILLAMETTE NATIONAL FOREST, OREGON

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INTRODUCTION

During the 1982 field season, Forest Pest Management personnel did a forest pest survey on both sides of Highway 126 from the McKenzie Ranger Station to Trail Bridge Reservoir (T. 16 S., R. 6 E., sec. 1, 2, 9, 10, 11, 12, 15, 16 and 17; T. 15 S., R. 6 E., sec. 11, 12, 13, 14, 23, 24, 25, 26, 35 and 36). The area examined extended from the McKenzie River to a line of up to approximately 2500 feet from the east-southeast side of the highway (Figure 1). Purposes of the evaluation were to determine causes and amount of pest losses, identify problem areas and develop management recommendations aimed at minimizing future losses. This information was requested by the District to be used in land management planning for the River Corridor.

METHODS

The area examined included only lands on the highway side of the river. Campgrounds and non-Federal ownerships were not surveyed. Transects were run at 5-chain (330') intervals from Highway 126 to the river and from the highway into the stands on the opposite side. The length of these lines and the subsequent area surveyed depended upon topography, ground conditions, and limits of what was considered to constitute the Corridor.

Approximately 2240 acres were surveyed systematically, using a variable radius plot method. Plots were placed at 5-chain (330') intervals along lines. A Spiegel-Relaskop was used to define each plot, and a basal area factor of 40 was used.

For each plot, the age class of the dominant stand component was estimated and recorded. These classes were:

- | | |
|---------------------------------|--|
| A - 0 to 30 years (Plantations) | D - 121 to 180 years (Mature-Overmature) |
| B - 31 to 80 years (Immature) | E - 181 years or older (Old-growth) |
| C - 81 to 120 years (Mature) | |

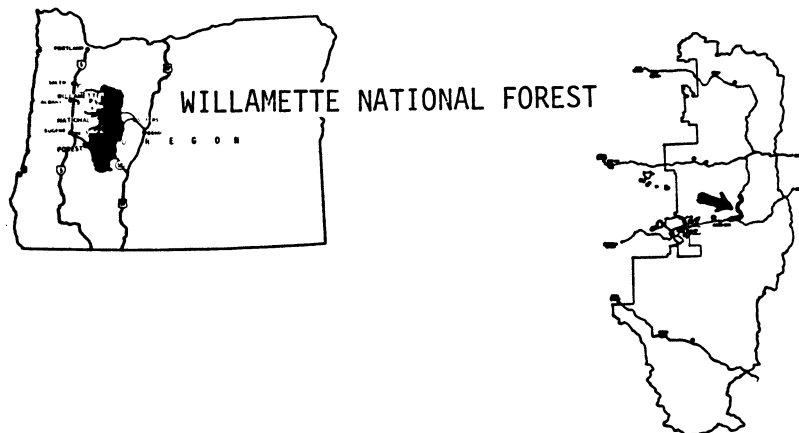
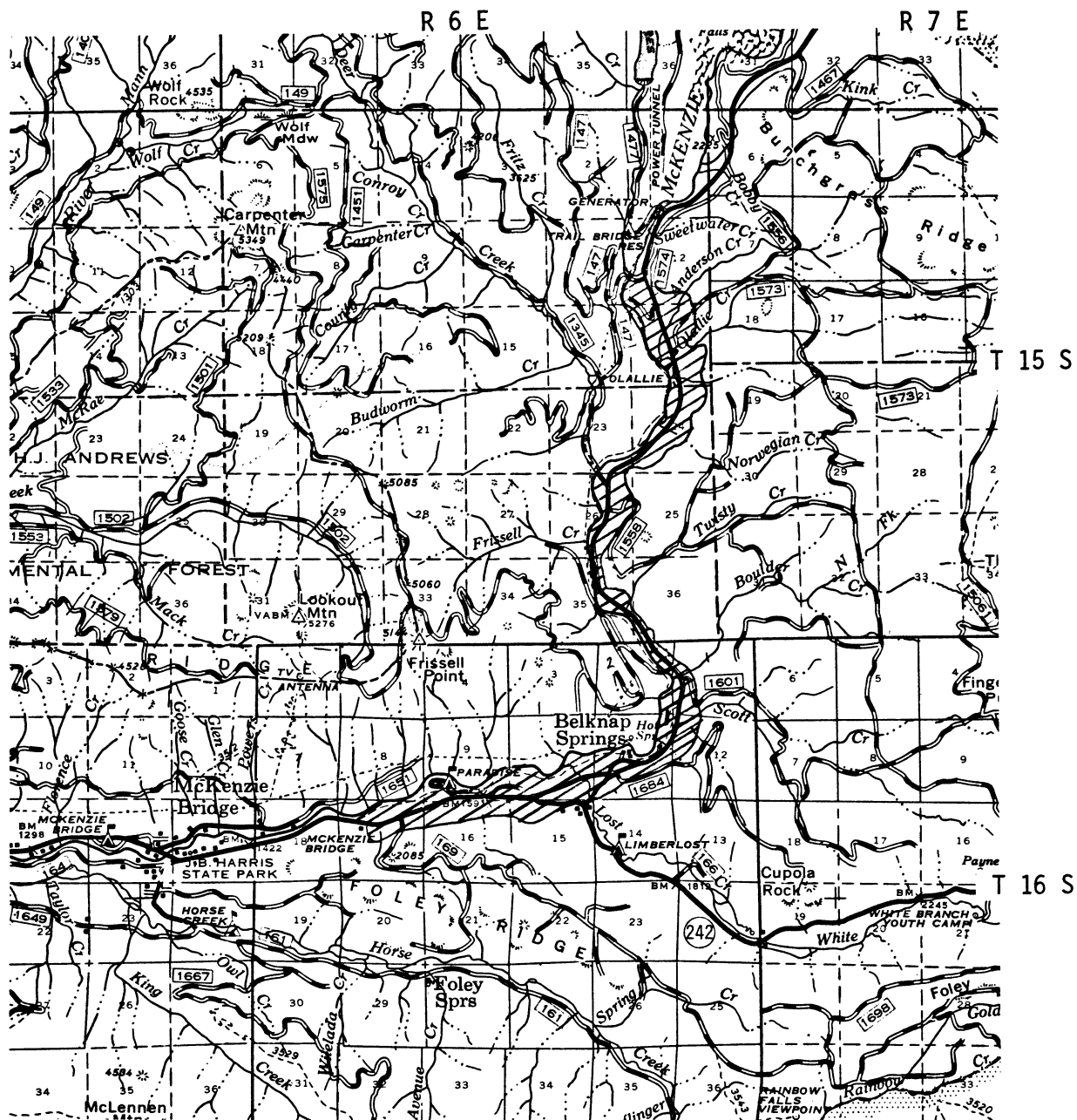


Figure 1. Map depicting location (crosshatching) of the survey area, McKenzie Ranger District, Willamette National Forest.

Each plot was examined for evidence of disease or insect infestation. This included dead or dying trees, old stubs or stumps, and/or less than normal stocking. Dead trees or trees exhibiting symptoms of root disease were examined to determine the causal pest. This involved (a) removing a section of bark from the boles of dead trees to check for bark beetles or their galleries; (b) removing a section of bark on one or more sides of the root collar, and exposing and dissecting portions of two or more large roots to check for stained wood or fungal growth characteristic of root disease fungi. In plots containing root disease or insect infestation, the following data were recorded for each tree in the plot: tree species, DBH, general condition (live, dead, standing, down), and presence of insects or diseases, including butt and heart-rots. Similar data were also recorded from every fifth plot throughout the survey. Plots were separated into the previously mentioned age classes, and mean basal area and number of trees per acre by tree species, DBH class, condition, and attacking pests were calculated for each.

In addition to collecting data at plots, the entire survey area was scrutinized for root diseases. This was done by reconnoitering a 2½-chain wide strip on either side of the line. Root disease centers were mapped with boundaries based on the furthest extent of dead or symptomatic trees. This information was used to make a composite map of the entire area.

RESULTS AND DISCUSSION

The survey revealed extensive losses to pests in the McKenzie River Corridor. Greatest losses are occurring in the stand age class 31 to 80, and these are predominantly caused by root rot. Root disease centers were found throughout most of the surveyed area. The most heavily infected stands were those between the McKenzie River Station and a mile north of the mouth of Scott Creek. Approximately 17 percent of the entire area surveyed is infected by root disease fungi. Pest-caused losses are adversely affecting McKenzie River Corridor management objectives and unless special actions are taken, losses will intensify.

Site quality in the McKenzie River Corridor between the McKenzie River Station and Trail Bridge Reservoir varies from moderately to highly productive and topography varies from relatively flat to steep slopes. The survey area is shown in Figure 2. A variety of age classes are present in stands within the Corridor, ranging from 15-year-old plantations to over 300-year-old timber. Most of the survey area has stands in Class E, the oldest age class (41.1%). Age Class A covers 5.9%; Class B, 13.5%; Class C, 12.9%; and Class D, 26.7% of the area.

Most of the young stands are predominantly composed of Douglas-fir (*Pseudotsuga menziesii*). Shade-tolerant species such as incense cedar (*Libocedrus decurrens*), western redcedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*) are increasingly more common in the older age classes, although Douglas-fir remains the dominant stand component. Minor species encountered include sugar pine (*Pinus lambertiana*) and grand fir (*Abies grandis*). Western white pine (*Pinus monticola*) was formerly common throughout the area, but most is now dead. Hardwood species, including bigleaf maple (*Acer macrophyllum*) and red alder (*Alnus rubra*) are common in some areas. Most of the older stands in the survey area have been periodically salvage-logged.

Most cutting levels have been light, with only dead and dying trees being removed. One large and several small clearcuts, and some group selection harvests were done in recent years. The harvested sites now have plantations to 28 years old.

Mean basal areas and number of trees per acre separated by age class are shown in Tables 1 through 5; the percentages of trees that were dead in Age Classes A, B, C, D, and E were 0.2, 10.4, 4.5, 8.9, and 5.3, respectively. Percentages of basal area contained in dead trees were 1.8, 5.4, 4.9, 4.1, and 3.4, respectively. Mean basal area and trees per acre summarized for the entire survey area are shown in Table 6. Dead trees made up 5.1 percent of the stems, and 4.3 percent of the basal area. Most mortality was due to root rots, especially laminated root rot, caused by *Phellinus* (*Poria*) *weirii*, and Armillaria root rot, caused by *Armillaria mellea*. Significant mortality has also resulted from windbreak, often involving trees weakened by red-brown butt rot, caused by *Phaeolus* (*Polyporus*) *schweinitzii*. Most western white pine and sugar pines, throughout the survey area have been killed by the mountain pine beetle, *Dendroctonus ponderosae*.

Trees and basal area per acre by condition and diameter class are shown in Tables 7, 8, 9, 10, 11 and summarized in 12.

Laminated root rot was the most frequently encountered mortality-causing disease throughout the survey area and affected trees in all age classes. Percentage of plots having at least one tree with this disease were 4.7, 7.1, 7.4, 11.9 and 11.0 for stand ages A through E, respectively. Locations of laminated root rot centers are shown in Figure 2.

Laminated root rot centers contain a large proportion of live trees identified as being infected. Plot data indicate that the number and basal area of living, infected trees approaches number and basal area of dead infected trees. Many susceptible trees are probably infected, yet have not started to exhibit crown symptoms; their condition was not identified in the survey. Based on recent studies done in British Columbia and eastern Washington, we suspect that only 50 percent of the number of trees actually infected produced crown symptoms. The large number of resistant species, including western redcedar and incense cedar, have minimized reduction in total stocking and, probably, disease spread.

Armillaria root rot was found in the survey area, causing mortality in numerous small disease centers. Trees in all age classes were affected. Percentage of cruise plots containing at least one dead or infected tree were 2.3, 5.1, 4.2, 3.6, and 1.3 for stand age classes A through E, respectively. Damage due to this root rot was slightly greater in younger age classes. Unlike laminated root rot, a difference in species susceptibility was not apparent. In disease centers, all species were being infected and killed. Stocking levels were usually low within centers due to the lack of any apparent resistance. Locations of Armillaria root rot centers are shown in Figure 2.

Annosus root rot, caused by *Fomes annosus*, was found infecting a very few western hemlock in plots in stand age classes C and E (Tables 9 and 11). Occasional scattered infected trees were observed throughout the survey. Decay usually was associated with an old wound.

Black stain root disease, caused by *Ceratocystis (Verticicladiella) wagen-eri*, was not identified infecting trees in plots but was observed during the survey. It was found on a few single, scattered sapling-sized trees along roads. The disease had not yet started to spread rapidly. One disease center, containing 8-12 trees, was identified within an 80-year-old stand (Figure 2).

Red-brown butt rot, caused by *Phaeolus (Polyporus) schweinitzii*, was most common in the older-aged stands. Percentages of infected Douglas-fir basal area were 0, 1.3, 2.3, 1.6 and 1.9 for stand age classes A through E, respectively. Similarly, percent tree per acre values were 0, 0.5, 1.0, 1.6 and 1.2. Occurrence was widely scattered and often not very evident. No attempt was made to map individual infected trees or small centers.

Red-ring rot, caused by *Fomes pini*, was present at high levels throughout the survey area. Douglas-fir was the only host found infected in cruise plots, although red-ring rot was observed damaging an occasional white pine and hemlock. Percentage of infected Douglas-fir trees per acre in age classes A through E were 0, 0.4, 2.0, 5.5 and 4.1. Percent basal area values were 0, 2.7, 5.5, 9.3 and 8.2.

The Douglas-fir beetle (*Dendroctonus pseudotsugae*) has caused scattered mortality throughout the older-age class stands. Most dead trees occurred singly, although a few small centers were found. Most group mortality has been salvaged, so levels of damage are not easily discerned. Mortality was identified on cruise plots in the three oldest-age classes. Percentage of Douglas-fir basal area that was killed by beetles was 0.1 for age classes C, D and E. Percent tree per acre figures were 0.3, 0.1, and 0.4, for the same age classes.

The mountain pine beetle (*Dendroctonus ponderosae*) has killed almost all of the white pine and sugar pine in the survey area. This insect has the ability to locate and attack scattered individuals in a stand. Trees are susceptible when they are older and in fully-to-overstocked conditions. The beetle also will attack trees weakened by white pine blister rust, caused by the fungus *Cronartium ribicola*. This disease was evident on some of the few surviving pine. Blister rust was probably partially responsible for a great deal of the insect-induced mortality in the area. Percent basal area losses due to mountain pine beetles for age classes A through E were 0, 33.3, 100, 100 and 12.5 of the total five-needle pine basal area. Percent trees per acre values were 0, 50, 100, 100 and 33.3.

DISEASE BIOLOGY AND IDENTIFICATION

Laminated Root Rot

Laminated root rot is a common disease in Pacific Northwest Region stands. It primarily causes tree mortality and continuing loss of productivity within disease centers. Growth loss of infected trees also occurs.

Variability in species susceptibility exists in western Oregon mixed-conifer stands. The most susceptible species occurring in the survey area are Douglas-fir and grand fir. Western hemlock is intermediately susceptible. Tolerant species include western white pine and sugar pine. Incense cedar and western redcedar are resistant, and all hardwood species are immune.

Laminated root rot can be identified from a variety of signs and symptoms. The disease usually causes patches or groups of dead and dying trees in pole-sized or larger stands. In younger stands, infection and mortality may be more scattered, in less apparent "patches." Infected trees exhibit crown symptoms including reduced height growth, thinning and chlorotic foliage, and an abnormal "distress" crop of abundant smaller-than-normal cones. Trees will usually be severely infected before crown symptoms are apparent. Such trees are prone to windthrow. Disease patches usually will appear as pockets of dead and down trees with infected trees exhibiting crown symptoms around the periphery. Less susceptible tree species may proliferate in disease centers, obscuring evidence of laminated root rot.

Diseased windthrown trees will frequently exhibit "root balls"; remnants of the root systems that are decayed and broken off just below the root collar. Exposed decayed wood will usually exhibit characteristic delaminations along the annual rings, pitting, and growth of reddish-brown setal hyphae between the sheets of decayed wood (Plate 1).

Living-diseased or recently-killed trees will often have whitish, crusty ectotrophic mycelia of the fungus growing on the surface of infected roots. On larger roots of older trees, this mycelium can usually be found in bark crevices.

P. weirii can survive as a saprophyte for many years on dead host material (large roots and stumps). New infections occur when roots of healthy susceptible trees contact this material. Centers develop when the pathogen grows from diseased trees and infects healthy trees via root contacts or grafts. Laminated root rot can thus remain on the site, infecting subsequent generations.

Disease centers expand as more trees become infected. The rate of expansion can be as much as 1 to 2 feet per year. Stands stocked by less susceptible species may slow the rate of expansion.

Armillaria Root Rot

Armillaria root rot is found throughout the Northwest on a variety of hosts. In western Oregon, this disease most commonly is found in plantations, especially where offsite stock was planted or local stock was poorly planted. Stressed trees of most species and all age classes are susceptible to attack. Douglas-fir is most susceptible when it is less than 30 years old. Occasionally, virulent strains of this fungus cause mortality to most species and age classes on a site.

As with laminated root rot, *A. mellea* can cause group mortality. Disease spread is similar, occurring across root contacts or grafts. Infective string-like fungal structures called rhizomorphs can also spread the fungus a short distance through the soil. In most cases this disease causes scattered mortality. Often, centers are small.

Crown symptoms caused by Armillaria root rot often include chlorotic foliage and/or a distress cone crop. Resinosis around the base of the bole is very common. Cream-colored mycelial fans are often found growing under the bark of the lower bole on the root collar and roots of infected trees (Plate 2). These can also be found on trees which have been dead for up to 3 years. The presence of rhizomorphs are also very diagnostic.

Annosus Root Rot

Annosus root rot causes decay and mortality in several Northwest timber species. In western Oregon stands, western hemlock is the most common host for this fungus. In western hemlock the loss due to this fungus is root and butt decay and predisposition to windthrow as a direct result of wounds. In unmanaged stands where wounding has been minimal, loss due to decay and windthrow should be low.

Fomes annosus spreads via airborne spores produced from perennial fruiting bodies. Spores can colonize fresh wound surfaces on host trees and later cause decay. Once established on stumps and roots, the mycelium grows along susceptible roots, spreading to adjacent trees across root contacts and grafts.

Black Stain Root Disease

In the Northwest, black stain root disease most commonly causes mortality in young Douglas-fir plantations. Occasionally, older fir will be attacked, as will several other tree species. This disease is most commonly found in stands which have been thinned and along roads, skid trails; sites that have had recent disturbances.

Mortality due to this disease occurs in patches that often show evidence of rapid expansion. Dead standing trees are often present with dying chlorotic trees occurring around the periphery.

This disease is a vascular wilt rather than a root rot. Initial infection is believed to be caused by fungal transmission by several species of bark beetles and weevils. Following infection, disease spreads from tree to tree via root contacts. Following host death, the fungus dies.

Black stain disease can be identified by cutting into the roots and root collar and finding the black- to chocolate-brown-colored stain in the sapwood (Plate 3).

Red-brown Butt Rot

Red-brown butt rot is common in mature to old-growth Douglas-fir. It causes a decay of the root system and heartwood of its host. The pathogen is usually not very aggressive and tree decline is slow following infection. Tree mortality usually results from windbreak or windthrow as a result of the decay. One or more other pests may be associated with mortality.

This disease commonly occurs at endemic levels in mature to overmature Douglas-fir stands. Special control measures are seldom required. Reinfection of new stands following harvest and regeneration does not appear to be a problem. Root contacts are probably the primary cause of spread within stands. Most infection centers include only a few trees.

The presence of "velvet-top" fruiting bodies are the best indicators of the disease. Trees which have "wind-broke" will exhibit the characteristic brown cubical rot caused by the fungus.

Red-ring Rot

Red-ring rot is a heartrot found in many conifer species. Individual trees will often have extensive decay throughout the bole. Losses increase with stand age, both as a result of number of trees infected and the amount of decay within each tree. Wood with advanced decay retains some structural strength and currently has some uses such as plywood core. Infected trees can be identified by the presence of fruiting bodies and, in many cases, swollen "punky knots." Spread of disease is by airborne spores infecting trees through branch stubs and possibly wounds.

White Pine Blister Rust

White pine blister rust is an introduced disease which attacks 5-needle pines. Cankers formed by the fungus girdle branches and boles. Death is often rapid in smaller trees. Sawlog-sized trees will usually decline slowly as branches are attacked and die. Other pests, such as bark beetles which prefer weakened hosts, will usually attack and kill infected trees. An abundance of susceptible hosts allows the beetle population to increase and the problem accelerates.

Cronartium ribicola requires two hosts to complete its life cycle. Aeciospores are produced on pines and infect *Ribes* spp. Basidiospores produced on *Ribes* spp. in turn reinfect pines. Susceptibility of pines to infection is based on the level of tree resistance and the hazard of the site. High-hazard sites are those where standard pine stock would suffer unacceptable levels of mortality through a rotation. Areas along streams and rivers, such as the survey area, are usually high-hazard.

Bark Beetles

Various bark beetles have different host selection/attack strategies. The Douglas-fir beetle is an opportunistic insect, attacking and breeding in diseased, injured or windthrown trees. It is seldom a primary tree killer under endemic population levels. A large amount of susceptible host material can allow the population to increase; subsequently, nearby healthy trees may be attacked.

The mountain pine beetle is a relatively aggressive insect. They will search out and attack susceptible hosts which may be only minor components of a stand. Trees are susceptible to attack by endemic populations of insects when they are overmature, diseased, stressed or in stands which are fully stocked.

ALTERNATIVES AND MANAGEMENT RECOMMENDATIONS

A variety of diseases and insects are causing damage to stands in the McKenzie River Corridor. Most pest losses can be minimized through an integrated approach to stand management. This includes maintaining stand vigor through stocking control, species manipulation, and length of rotation. Implementing these management activities must follow consideration of impacts and benefits to other resources. Oftentimes, some losses must be accepted when other resource considerations are deemed important and conflict with pest management strategies.

Stand management decisions should be based on information that includes pest losses. We feel that stands should be treated on the basis of past pest severity and the potential for future losses. Stand age usually determines general levels of decay losses and root disease treatment alternatives. Surveyed stands are delineated by age class. This information can be used in deciding if an intermediate entry or a final harvest should be used in high-loss stands.

The most serious pest problems in the surveyed area are root diseases, laminated root rot and Armillaria root rot, specifically. The availability of management alternatives for dealing with root disease problems depends upon types of root disease, and stand and site characteristics.

The following alternatives are suggested:

Laminated Root Rot

In *P. weirii*-infected, young, second-growth Douglas-fir stands, levels of loss should be periodically evaluated to determine whether a shortened rotation is necessary. In mature to overmature stands that are understocked due to disease, a high priority of treatment should be assigned. Regenerating these stands following harvest will require precautions to prevent future losses.

In mature to overmature stands where a large number of resistant species, such as western redcedar and incense cedar, have maintained full stocking in disease centers, harvesting and regenerating to Douglas-fir may be more costly and result in a greater level of resource damage than implementing other management alternatives such as maintaining a high proportion of resistant species.

Laminated root rot can only be effectively treated prior to stand reestablishment. Following harvest of the existing stand, less-susceptible species must be planted or infective material must be removed or rendered sterile if disease losses are to be minimized.

Boundaries of disease centers should be identified on the ground prior to logging and immediately after felling. For about 3 to 4 weeks after exposure, a crescent-shaped, red-brown stain usually is present on cut surfaces of infected stumps. Treatment area should extend 50' beyond the last symptomatic tree or stump in a center.

Regenerating less susceptible species within disease centers will minimize future losses. Planting IMMUNE--bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*); RESISTANT--incense cedar, western redcedar; or TOLERANT--western white pine, sugar pine, will minimize future losses and perpetuation of infective material in the soil. Following at least a 50-year rotation of such species excluding susceptible species; Douglas-fir could be safely regrown. Western hemlock, a tree intermediately susceptible to *P. weirii*, can be grown in disease centers with minimal loss over a generation; however, some trees may become infected and disease will be carried over to the subsequent generation.

When susceptible trees, such as Douglas-fir, are replanted in disease areas, the site should be treated to avoid unacceptable losses. Stump removal can be accomplished with heavy equipment or explosives. Possible soil disturbance and compaction, soil nutrient drain, and steep topography are drawbacks to stump removal. The use of fumigants directly applied to infected stumps has

been used on an experimental basis. Soil fumigation avoids most of the disadvantages of stump removal; however, it may have other unknown disadvantages since the system is still experimental.

Costs for removing or fumigating stumps are high, \$400-600/acre. Contact Forest Pest Management for further information and possible funding of control projects.

Armillaria Root Rot

In young plantations, *A. mellea* is occasionally common, causing single tree or small group mortality. These levels of disease should be monitored. By age 30, continuing mortality should be rare. If unacceptable losses are still occurring at age 30, management strategy may have to be altered. If infected stands are scheduled for precommercial thinning, surviving trees within disease centers should not be thinned if stocking exceeds the prescription spacing. Contract crews should be able to identify Armillaria centers by observing basal resinosis on dying trees (Plate 4).

In several maturing commercial-sized stands, a number of small disease centers are causing losses. These stands are predominantly Douglas-fir. Current losses do not warrant immediate action. However, if commercial thinnings are planned, losses to mortality should be minimized by harvesting all trees with symptoms of root rot and all trees within 30 feet of them. Stands planned for older rotation ages should have the disease situation reassessed at the time of final harvest. If these stands are harvested within 20 years, replanting with vigorous, high quality stock and maintaining vigor through stocking control should minimize losses.

In several mature-overmature stands, Armillaria root rot is locally severe. Unlike laminated root rot, disease centers are all understocked (or nonstocked) since all tree species are apparently susceptible. The disease is aggressive, probably because the causal fungus is highly pathogenic. Regenerating these centers will probably not be successful without treating the site by removing or sterilizing the inoculum. Stump removal is probably the most viable alternative for treating this disease in such situations. If this alternative is implemented, we recommend that treatment areas be accurately identified on the ground and a buffer strip of 50' be added to the apparent center boundaries. Following harvest, stumps should be removed and the soil raked to rooting depth to remove large infective material. Douglas-fir or any other adapted species could then be planted.

Black Stain Root Disease

Black stain root disease was found in several areas on single trees, usually saplings. One disease center was found in maturing timber (Figure 2).

Management action is not warranted for the current disease condition observed in very small centers. If spreading black stain centers are found, we recommend slashing all Douglas-firs within centers, including a 25' buffer strip. Treated areas may be replanted immediately with a nonhost such as hemlock or cedar or 1 year later with Douglas-fir.

The disease center found in the older stand should be treated by incorporating it within an upcoming sale scheduled for the area. Treatment should involve clearcutting all trees within the center and a 50' buffer strip. Extent of the center should be determined from trees displaying crown symptoms. Douglas-fir may be replanted 1 year after cutting.

Annosus Root Rot

Annosus root rot occurs at low levels, thus not warranting any immediate management action. Care should be taken to minimize wounding residuals during future partial harvests in stands with a significant component of hemlock.

Other Pests

Losses to other diseases and insect pests may best be minimized by managing stands on shorter rotations and including intermediate harvests in management plans to capture mortality and maintain vigor. Losses caused by *F. pini* and *P. schweinitzii* can be expected to remain high in most overmature stands where Douglas-fir is a major stand component.

Insect-caused mortality can also be minimized by maintaining stand vigor and shorter rotations. Western white pine is an excellent alternative species for planting in laminated root rot centers. Bark beetle-caused mortality may be minimized in these areas by maintaining 1 inch in radial diameter growth every 10 years on individual crop trees through stocking control. Since blister rust hazard appears to be high in this area, resistant stock should be used.



Plate 1. Laminated decay and setal hyphae characteristic of *Phellinus weirii*



Plate 2. Mycelial fans characteristic of *Armillaria mellea*

Plate 3. Black stained sapwood
characteristic of
Ceratocystis wageneri



Plate 4. Basal resinosis on a
young Douglas-fir caused
by *Armillaria mellea*

Table 1--Mean Basal Area (ft.²) and Trees per Acre by Diameter Class, Species, and Tree Condition, McKenzie River Corridor.

DBH Class	Age Class A (0-30 Years)					
	DOUGLAS-FIR				CEDARS	
	Alive		Dead		Alive	
	T/A	BA	T/A	BA	T/A	BA
4	152.8	13.3				
6	101.9	20.0			67.9	13.3
8	38.2	13.3			38.2	13.3
10	97.8	53.4				
16			0.7	0.9		
20			0.4	0.9		
24					4.2	13.3
58	0.4	6.7	< 0.1	0.9		
60	0.3	6.7				
Totals	391.4	113.4	1.1	2.7	110.3	39.9

Table 2--Mean Basal Area (ft.²) and Trees per Acre by Diameter Class,
Species, and Tree Condition, McKenzie River Corridor.

DBH Class	Age Class B (31-80 Years)											
	DOUGLAS-FIR				CEDARS		WESTERN HEMLOCK		OTHER SPECIES			
	Alive		Dead		Alive		Alive		Alive		Dead	
	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA
4			4.7	0.4								
6	32.6	6.4	4.2	0.8	8.1	1.6						
8	13.8	4.8	2.3	0.8	4.6	1.6						
10	2.9	1.6	1.5	0.8	5.8	3.2	2.9	1.6				
12	8.2	6.4				0.0						
14	3.0	3.2	0.8	0.8	1.5	1.6						
16	10.3	14.4	0.6	0.8								
18	6.3	11.2	0.7	1.2	0.9	1.6					0.2	0.4
20	10.5	22.8	0.6	1.2	0.7	1.6						
22	6.3	16.4			0.6	1.6					0.2	0.4
24	4.1	12.8	0.1	0.4	2.0	6.4						
26	3.7	13.6							0.4	1.6		
28	1.1	4.8										
30	1.3	6.4	0.2	0.8								
32	1.4	8.0			0.3	1.6						
34	0.1	0.4										
36	0.3	3.6	0.1	0.8								
38	1.0	8.0	0.1	0.4								
40	0.7	6.4										
42	0.5	5.0										
44	0.3	3.2										
46	0.6	6.4										
48	0.0	0.0										
50	0.4	4.8										
Total	109.4	170.6	15.9	9.2	24.5	20.8	2.9	1.6	0.4	1.6	0.4	0.8

Table 3--Mean Basal Area (ft.²) and Trees per Acre by Diameter Class, Species, and Tree Condition, McKenzie River Corridor.

DBH Class	Age Class C (81-120 Years)											
	DOUGLAS-FIR				CEDARS		WESTERN HEMLOCK				OTHER SPECIES	
	Alive		Dead		Alive		Alive		Dead		Dead	
	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA
6			4.3	0.9			13.6	2.7				
8	7.6	2.7	2.4	0.9								
10	14.7	8.0										
12	17.0	13.3	1.6	1.3			6.8	5.3				
14	5.0	5.3	0.4	0.4			7.5	8.0	0.4	0.4		
16	5.7	8.0	0.9	1.3			3.8	5.3				
18	4.5	8.0	0.2	0.4								
20	6.1	13.3	0.8	1.7					0.2	0.4		
22	8.1	21.3	0.3	0.9	3.0	8.0						
24	3.4	10.7	0.1	0.4								
26	1.4	5.3	0.1	0.4	0.7	2.7						
28			0.2	0.9								
30	4.9	24.0	0.2	0.9								
32	4.8	26.7	0.2	1.3							0.1	0.4
34	2.1	13.3										
36	2.6	18.7	0.1	0.4							0.1	0.4
38	1.7	13.3	0.1	0.4								
40	1.8	16.0	0.1	0.4								
42	0.6	5.3										
44	1.3	13.3										
46	0.5	5.3	<0.1	0.4	0.2	2.7						
48	0.4	5.3	0.1	1.7								
50	0.8	10.7										
52	0.2	2.7										
54	0.3	5.3										
56	0.2	2.7										
58	0.1	5.3										
60												
62			<0.1	0.4								
Totals	95.8	263.8	12.2	15.4	3.9	13.4	31.7	21.3	0.6	0.8	0.2	0.8

Table 4--Mean Basal Area (ft.²) and Trees per Acre by Diameter Class, Species, and Tree Condition, McKenzie River Corridor.

DBH Class	Age Class D (121-180 Years)													
	DOUGLAS-FIR				CEDARS				WESTERN HEMLOCK				OTHER SPECIES	
	Alive		Dead		Alive		Dead		Alive		Dead		Dead	
	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA
4									12.7	1.1				
6	5.7	1.1			17.0	3.0								
8	9.5	3.3			3.2	1.1			6.4	2.2				
10	2.0	1.1	0.8	0.4					2.0	1.1	0.4	0.2		
12	1.4	1.1	1.1	0.8	2.8	2.2								
14			1.0	1.0	1.0	1.1			1.0	1.1				
16	4.0	5.6	0.7	1.0										
18	3.8	6.7	0.5	0.8	1.9	3.3			1.3	2.2				
20	3.1	6.7	0.3	0.6	0.5	1.1			0.5	1.1				
22	5.1	13.3	0.3	0.8	1.3	3.3			0.4	1.1				
24	5.3	16.7	0.3	0.8	0.3	1.1	0.1	0.2						
26	2.7	10.0	0.3	1.0	2.1	7.8								
28	3.1	13.3	0.1	0.4	1.0	4.4								
30	5.4	26.7	0.3	1.6	0.2	1.1								
32	3.4	18.9	0.1	0.8	0.2	1.1								
34	1.9	12.2	0.2	1.4										
36	2.4	16.7	0.1	0.1	0.3	2.2								
38	1.1	8.9	0.1	0.4	0.4	3.3								
40	1.9	16.7	<0.1	0.4	0.3	2.2								
42	0.7	6.7												
44	1.5	15.6	<0.1	0.4	0.2	2.2								
46	1.3	14.4	0.1	0.6										
48	0.9	11.1	<0.1	0.4										
50	0.7	8.9												
52	0.2	3.3												
54	0.5	7.8												
56	0.1	1.1												
58	0.1	2.2												
60	0.1	2.2												
62														
64	0.1	2.2												
66	<0.1	1.1												
Totals	68.0	255.6	6.4	14.6	32.7	40.5	0.1	0.2	24.3	9.9	0.4	0.4	0.1	0.4

Table 5—Mean Basal Area (ft.²) and Trees per Acre by Diameter Class, Species, and Tree Condition, McKenzie River Corridor.

DBH Class	Age Class E (>181 Years)															
	DOUGLAS-FIR				CEDARS				WESTERN HEMLOCK				OTHER SPECIES			
	Alive		Dead		Alive		Dead		Alive		Dead		Alive		Dead	
	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA
6	3.7	0.7			18.5	3.6										
8	2.1	0.7			4.2	1.5										
10	4.0	2.2	0.7	0.4	9.3	5.1					0.2	0.1				
12	3.7	2.9	0.9	0.7	2.8	2.2			3.7	2.9	0.2	0.1				
14	3.4	3.6	0.4	0.4	3.4	3.6			2.0	2.2						
16	3.6	5.1	0.7	0.9	1.6	2.2			2.6	3.6	0.1	0.1				
18	4.5	8.0	0.3	0.5	2.9	5.1			2.5	4.4						
20	2.3	5.1	0.3	0.7	1.0	2.2			2.0	4.4					<0.1	0.1
22	3.0	8.0	0.2	0.4	0.6	1.5	0.1	0.1	2.9							
24	1.2	3.6			0.9	2.9			0.5	1.5						
26	3.4	12.4	0.1	0.4	1.4	5.1					<.01	0.1				
28	1.2	5.1	0.1	0.4	0.5	2.2			0.2	0.7	<.01	0.1				
30	1.9	9.5	0.2	0.8	1.2	5.8										
32	2.1	11.6	0.1	0.4	0.9	5.1			0.4	2.2			0.1	0.7		
34	2.1	13.1	0.1	0.7	0.7	4.4										
36	1.1	8.0	<0.1	0.3	0.1	0.7										
38	1.1	8.7	<0.1	0.3	0.5	3.6			0.1	0.7					<0.1	0.1
40	0.8	6.5	<0.1	0.4	0.1	0.7			0.1	0.7						
42	0.9	8.7	0.1	0.5	0.3	2.9										
44	1.0	10.2														
46	1.2	13.8	<0.1	0.1									0.1	0.7		
48	0.8	10.2	<0.1	0.1	0.1	0.7										
50	0.9	12.4			0.1	0.7										
52	0.5	8.0			0.1	<0.7										
54	0.5	8.0	<0.1	0.1												
56	0.4	7.3														
58	0.2	4.4														
60	0.2	4.4			<0.1	0.7										
62	0.3	5.8														
64																
66	0.1	2.2														
68																
70	0.1	1.5	<0.1	0.1												
72			<0.1	0.1												
74																
76	<0.1	0.7														
Total	52.3	212.4	4.5	8.5	51.2	63.2	0.1	0.1	15.2	26.2	0.5	0.5	0.2	1.4	0.1	0.2

Table 6—Mean Basal Area (ft.²) and Trees per Acre by Diameter Class,
Species, and Tree Condition, McKenzie River Corridor.

DBH Class	Summary (All Age Classes)															
	DOUGLAS-FIR				CEDARS				WESTERN HEMLOCK				OTHER SPECIES			
	Alive		Dead		Alive		Dead		Alive		Dead		Alive		Dead	
	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA
6	28.5	6.3	2.3	0.5	19.7	4.4			6.5	1.2						
12	16.3	11.4	2.1	1.7	12.9	8.5			5.5	4.6	0.3	0.3				
18	13.8	24.2	1.5	2.4	3.1	5.6			3.7	6.3	0.1	0.2			0.1	0.2
24	10.5	32.4	0.4	1.3	3.2	10.2	<0.1	0.2	0.8	2.1	<0.1	0.2	0.1	0.3	<0.1	0.1
30	7.0	35.0	0.4	1.8	1.5	7.2			0.3	1.2	0.1	0.1	0.1	0.3	<0.1	0.1
36	4.1	29.2	0.2	1.5	0.7	5.0			<0.1	0.3					<0.1	0.2
42	2.9	27.4	0.1	0.6	0.3	2.7			<0.1	0.3			0.1	0.3		
48	2.3	28.0	0.1	0.7	0.1	0.9										
54	0.9	14.0	<0.1	0.1	<0.1	0.3										
60	0.4	7.5	<0.1	0.1	<0.1	0.3										
66	0.1	1.8														
72	<0.1	0.6	<0.1	0.2												
78	<0.1	0.3														
Total	86.8	218.1	7.2	10.9	41.6	45.1	<0.1	0.2	16.8	16.0	0.5	0.8	0.2	0.9	0.1	0.6

Table 7--Mean Basal Area (ft.²) and Trees Per Acre
by Pest, Condition, and Diameter Class,
McKenzie River Corridor.

Age Class A (0-30 Years)						
DBH Class	INFECTED LIVING TREES				INFECTED DEAD TREES	
	<i>Phellinus</i>		<i>Armillaria</i>		<i>Phellinus</i>	
	<i>weirii</i>		<i>mellea</i>		<i>weirii</i>	
	T/A	BA	T/A	BA	T/A	BA
4			10.7	0.9		
6	4.7	0.9	4.7	0.9		
8	2.7	0.9				
10	1.7	0.9	1.7	0.9		
16					0.7	0.9
20					0.4	0.9
58					<0.1	0.9
Total	9.1	2.7	17.1	2.7	1.1	2.7

Table 8—Mean Basal Area (ft.²) and Trees per Acre by Pest, Condition, and Diameter Class, McKenzie River Corridor.

Age Class B (31-80 Years)														
DBH Class	INFECTED LIVING TREES						INFECTED DEAD TREES							
	<i>Phellinus weirii</i>		<i>Polyporus schweinitzii</i>		<i>Fomes pini</i>		<i>Phellinus weirii</i>		<i>Polyporus schweinitzii</i>		<i>Armillaria mellea</i>		<i>Dendroctonus ponderosae</i>	
	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA
4												4.7	0.4	
6												2.1	0.4	
8												2.3	0.8	
10												0.7	0.4	
12							1.0	0.8						
14														
16														
18							0.2	0.4					0.2	0.4
20	0.2	0.4					0.2	0.4						
22	0.2	0.4											0.2	0.4
24							0.1	0.4						
26	0.1	0.4	0.3	1.1										
28							0.1	0.4	0.1	0.4				
30							0.1	0.4	0.1	0.4				
32														
34	0.1	0.4												
36	0.1	0.4					0.1	0.4	0.1	0.4				
38											0.1	.04		
40														
42					0.5	4.8								
44														
46														
48														
50														
Totals	0.7	2.0	0.3	1.1	0.5	4.8	1.8	3.2	0.3	1.2	9.9	2.4	0.4	0.8

Table 9—Mean Basal Area (ft.²) and Trees per Acre by Pest, Condition, and Diameter Class, McKenzie River Corridor.

DBH Class	Age Class C (81-120 Years)																			
	INFECTED LIVING TREES										INFECTED DEAD TREES									
	<i>Phellinus weirii</i>	<i>Armillaria mellea</i>	<i>Polyporus schweinitzii</i>	<i>Fomes pini</i>	<i>Fomes annosus</i>						<i>Phellinus weirii</i>	<i>Armillaria mellea</i>	<i>Polyporus schweinitzii</i>	<i>Dendroctonus ponderosae</i>	<i>Dendroctonus pseudotsugae</i>					
	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA
6											2.2	0.4								
8																				
10																				
12	0.5	0.4					0.5	0.4					1.1	0.9						
14																				
16																			0.3	0.4
18																				
20							0.5	1.4												
22											0.5	1.3								
24																				
26																				
28	0.1	0.4			0.3	1.4					0.1	0.4			0.1	0.4				
30							0.3	1.4			0.1	0.4			0.1	0.4				
32					0.3	1.4	0.3	1.4			0.1	0.4					0.1	0.4		
34	0.1	0.4					0.2	1.4												
36	0.1	0.4													0.1	0.4	0.1	0.4		
38	0.1	0.4																		
40							0.2	1.4												
42							0.2	1.4												
44	<0.1	0.4					0.1	1.4												
46					0.1	1.4	0.1	1.4												
48			<0.1	0.4											0.1	0.9				
50							0.2	2.9												
52																				
54																				
56							0.1	1.4												
62											<0.1	0.4								
Totals	0.9	2.4	<0.1	0.4	0.7	4.2	2.2	15.4	0.5	0.4	3.1	3.3	1.1	0.9	0.4	2.1	0.2	0.8	0.3	0.4

Table 10--Mean Basal Area (ft.²) and Trees per Acre by Pest, Condition, and Diameter Class, McKenzie River Corridor.

Age Class D (121-180 Years)																	
DBH Class	INFECTED LIVING TREES						INFECTED DEAD TREES										
	Phellinus weirii		Polyporus schweinitzii		Fomes pini		Phellinus weirii		Armillaria mellea		Polyporus schweinitzii		Dendroctonus pseudotsugae		Dendroctonus ponderosae		
	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	
10							0.4	0.2									
12							0.5	0.4									
14	0.2	0.2					0.4	0.4	0.2	0.2	0.2	0.2					
16	0.1	0.2									0.1	0.2					
18	0.1	0.2			0.7	1.2											
20					0.3	0.6	0.2	0.4			0.1	0.2					
22							0.1	0.2			0.1	0.2					
24	0.2	0.6			0.4	1.2	0.1	0.4	0.1	0.2	0.1	0.2					
26	0.3	1.2	0.3	1.2	0.2	0.6	0.1	0.4	0.1	0.2							
28	0.1	0.6					0.1	0.4									
30	0.1	0.4	0.1	0.6	0.5	2.4	0.2	1.0	<0.1	0.2	<0.1	0.2					
32	0.1	0.6			0.1	0.6	0.1	0.6							0.1	0.4	
34	0.1	0.8	0.1	0.6	0.4	2.4	0.2	1.0			<0.1	0.2					
36	0.1	0.6			0.2	1.8	0.1	0.8	<0.1	0.2							
38	0.1	0.4					0.1	0.4									
40	<0.1	0.4			0.3	2.4	<0.1	0.2	<0.1	0.2							
42	0.1	0.8			0.1	0.6											
44	<0.1	0.2			0.1	0.6	<0.1	0.2									
46					0.4	4.1	<0.1	0.4	<0.1	0.4							
48	<0.1	0.4									<0.1	0.2	<0.1	0.2			
50					0.2	2.4											
52	<0.1	0.6			<0.1	0.6											
54					0.1	1.8											
56																	
58					<0.1	0.6											
60					0.1	1.2											
66					<0.1	0.6											
Total	1.7	8.2	0.5	2.4	4.1	25.1	2.7	7.4	0.5	1.4	0.7	1.8	<0.1	0.2	0.1	0.4	

Table 11—Mean Basal Area (ft.²) and Trees per Acre by Pest, Condition, and Diameter Class, McKenzie River Corridor.

Age Class E (≥ 181 Years)																				
INFECTED LIVING TREES										INFECTED DEAD TREES										
DBH Class	Fomes annosus		Phellinus weirii		Armillaria mellea		Polyporus schweinitzii		Fomes pini		Phellinus weirii		Armillaria mellea		Polyporus schweinitzii		Dendroctonus pseudotsugae		Dendroctonus ponderosae	
	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA
6																				
8																				
10			0.2	0.1							0.5	0.3	0.2	0.1						
12			0.2	0.1							0.7	0.5			0.2	0.1				
14											0.4	0.4								
16	0.1	0.1	0.3	0.4							0.3	0.4	0.2	0.3			0.1	0.1		
18			0.1	0.1					0.2	0.4	0.2	0.4			0.1	0.1				
20			0.2	0.4					0.2	0.4	0.2	0.5								
22			0.3	0.7							0.1	0.1	0.1	0.1					0.1	0.1
24			0.1	0.4					0.1	0.4			<0.1	0.1						
26			0.1	0.3					0.2	0.8	0.1	0.3			<0.1	0.1				
28			0.1	0.4					0.1	0.4	0.1	0.3					<0.1	0.1		
30			<0.1	0.1					0.1	0.4	0.1	0.5	<0.1	0.1			<0.1	0.1		
32			0.1	0.4					0.1	0.4	0.1	0.4			<0.1	0.1				
34			<0.1	0.1							0.1	0.5	<0.1	0.1						
36			0.1	0.7			0.1	0.4	0.1	0.4	<0.1	0.3								
38			<0.1	0.4	<0.1	0.1			0.3	2.0	<0.1	0.3			<0.1	0.1	<0.1	0.1	<0.1	0.1
40			<0.1	0.3			<0.1	0.4	0.1	0.8	<0.1	0.1					<0.1	0.1		
42			<0.1	0.3			<0.1	0.4	0.1	1.2	0.1	0.5								
44							<0.1	0.4	0.1	1.2										
46									0.1	1.2	<0.1	0.1								
48			<0.1	0.1			0.1	1.2	0.1	1.6	<0.1	0.3								
50			<0.1	0.1					0.1	1.6										
52			<0.1	0.1					<0.1	0.4										
54			<0.1	0.1					0.1	2.0					<0.1	0.1				
56			<0.1	0.1					<0.1	0.4	<0.1	0.1								
58									0.1	1.2					<0.1	0.1				
60							<0.1	0.4	<0.1	0.4					<0.1	0.1				
62							<0.1	0.4	<0.1	0.4										
64							<0.1	0.4	<0.1	0.4										
66			<0.1	0.1																
68															<0.1	0.1				
70																				
72															<0.1	0.1				
74																				
76																				
Total	0.1	0.1	2.2	5.8	<0.1	0.1	0.3	3.2	2.3	18.0	3.1	6.3	0.6	0.9	0.4	0.9	0.2	0.4	0.1	0.2

Table 12--Mean Basal Area (ft.²) and Trees per Acre by Pest,
Condition and Diameter Class, McKenzie River Corridor

Summary (All Age Classes)																					
DBH - Class		INFECTED LIVING TREES										INFECTED DEAD TREES									
		Phellinus weirii		Armillaria mellea		Polyporus schweinitzii		Fomes pini		Fomes annosus		Phellinus weirii		Armillaria mellea		Polyporus schweinitzii		Dendroctonus ponderosae		Dendroctonus pseudotsugae	
		T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA
6	0.2	0.1	0.9	0.2								0.6	0.3	1.4	0.4						
12	0.3	0.3	0.1	0.1					0.1	0.1		1.2	0.9	0.3	0.3	0.7	0.6				
18	0.4	0.5					0.8	1.5	<0.1	0.1		0.4	0.9	0.1	0.1	0.5	0.9	<.1	0.1	0.1	0.1
24	0.3	1.1			0.2	0.9	0.6	2.1				0.3	0.7	0.1	0.3	0.5	1.5	<.1	0.1		
30	0.2	0.7			0.3	0.9	0.7	3.0				0.3	1.5	<0.1	0.1	0.4	1.5	<.1	0.1	<.1	0.2
36	0.2	1.2	<0.1	0.1	0.1	0.6	0.6	4.2				0.2	0.7	<0.1	0.3	0.1	0.9	<.1	0.2		
42	0.1	0.8			0.1	0.9	0.6	5.8				<0.1	0.4			<0.1	0.3			<.1	0.1
48	<0.1	0.3	<0.1	0.1	0.1	1.2	0.6	7.3				<0.1	0.1	<0.1	0.1	0.1	0.9			<.1	0.1
54	<0.1	0.4			0.1	3.5						<0.1	0.1			<0.1	0.3				
60	0.0	0.0			<0.1	0.3	0.1	2.4				<0.1	0.1			<0.1	0.6				
66	<0.1	0.1					<0.1	0.6													
72														<0.1	0.1	<0.1	0.3				
Total	2.0	5.5	1.0	0.5	0.8	31.8	4.1	30.4				2.9	5.8	2.0	1.7	2.4	7.8	0.1	0.5	0.1	0.5

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Figure 2

FIGURE 2

MCKENZIE RIVER CORRIDOR FOREST PEST SURVEY

MCKENZIE RANGER DISTRICT

WILLAMETTE NATIONAL FOREST

1982

LEGEND

- SURVEY BOUNDARY
- o PLOT LOCATION
- ROOT DISEASE CENTER
- PW LAMINATED ROOT ROT
- AM ARMILLARIA ROOT ROT
- CW BLACK STAIN ROOT DISEASE
- STAND AGE CLASS BOUNDARY
- A 0 - 30 YEARS
- B 31 - 80 YEARS
- C 81 - 120 YEARS
- D 121 - 180 YEARS
- E 181 + YEARS

